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Re:	For consideration in Working Group Recirculation Ballot #14b, on P802.16d/D3.
Abstract	By adapting tile-based power control, the uplink performance in OFDMA system is enhanced in the NLOS environment.
Purpose	Adoption
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Uplink Power Control Enhancement for 802.16e OFDMA PHY

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1. Introduction

In IEEE P802.16e/D2-2004, the fast uplink power control is supported by using Fast tracking indication in the UL-MAP (as shown in Table 263b). The average received power from all Subscriber Stations (SS) at the Base Station (BS) are kept at the same level through this mechanism. The uplink power control mechanism based on the SS average power works fine in LOS case.

However, in the NLOS environment,

1. the received power in different subcarriers may vary vastly due to the multipath effect.
2. the Inter-Carrier Interference (ICI) occurs due to frequency offset and the non- orthogonal nature on uplink.

Due to the difference of local oscillator and existence of Doppler shift, the frequency offsets of the received signals from different SSs are not coordinated. ICI occurs between two neighboring subcarriers that belong to different SSs.

As specified in the current standard, the Subscriber Stations (SS) shall be synchronized to the BS with a tolerance of maximum 2% of the subcarrier spacing. The adjacent subcarriers, which belong to two different SSs, may have the opposite-direction frequency shift, thus the ICI is caused by the summation of the frequency shifts of the signals from two SSs.

Therefore, strong power in a subcarrier may generate an ICI that destroys the reception of the weak signal in its adjacent subcarrier. This symptom is similar to that caused by near-far effect.

The ICI in NLOS case can be illustrated in a simple OFDMA system as shown in Figure 1. There are three SSs in this system, representing by green, red, blue colors, respectively. Each SS transmit in a tile that consists of 4 consecutive subcarriers by 3 OFDM symbols. Due to multipah effect, red signals are much stronger than their neighbors. The accumulated ICIs represented in black lines may hamper the reception of the blue signal at subcarrier 2 and green signal at subcarrier -3.

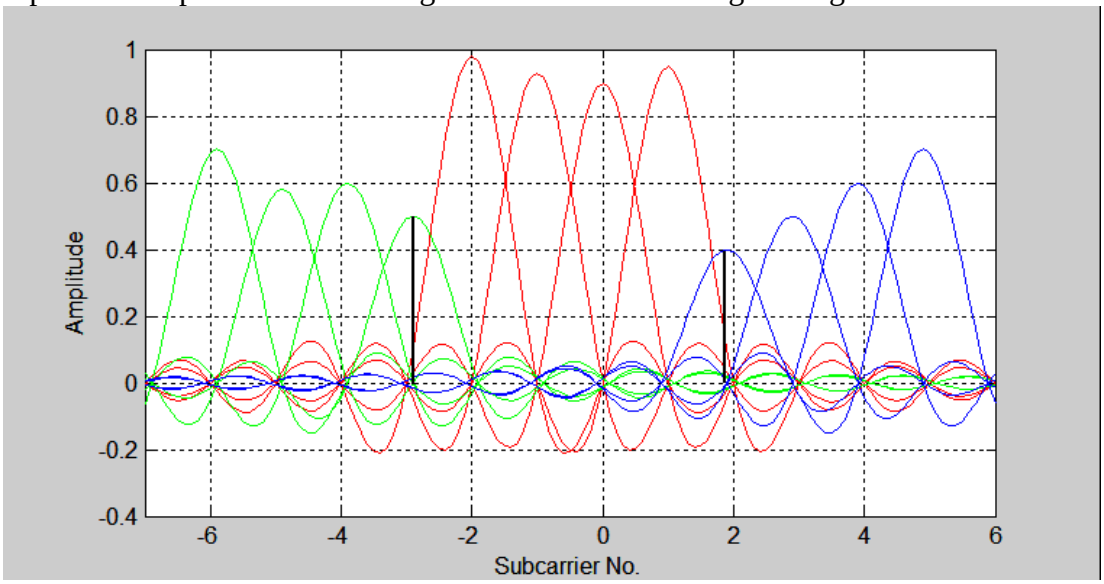

Fig.1 Received frequency-domain signal in Base Station

2. The Solution

Based on the analysis above, we propose the tile-based power control. The Base Station (BS) measures the average power of the tile, and then feeds back the adjustment command to the SS. The SS performs the power adjustment in digital domain. This accurate uplink power control eliminates the near-far effect in OFDMA system.

3. Performance

In the simulation, Doppler frequency of 2 Hz is assumed. In this pedestrian case, radio channel varies slowly with time. Thus an instance of amplitude-frequency response in SUI5 channel model, as shown in Figure 2, is used in the simulation. In this instance, deep fading of more than 10dB exists.

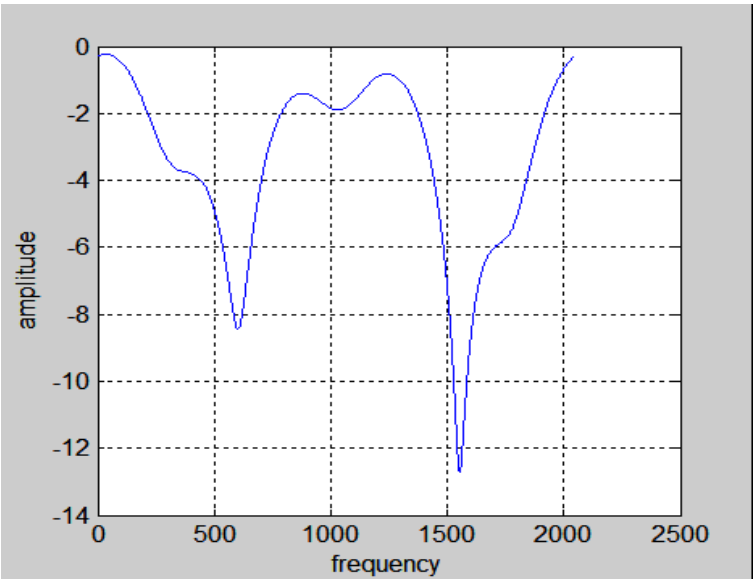

Fig.2 The instance of amplitude-frequency response for SUI5

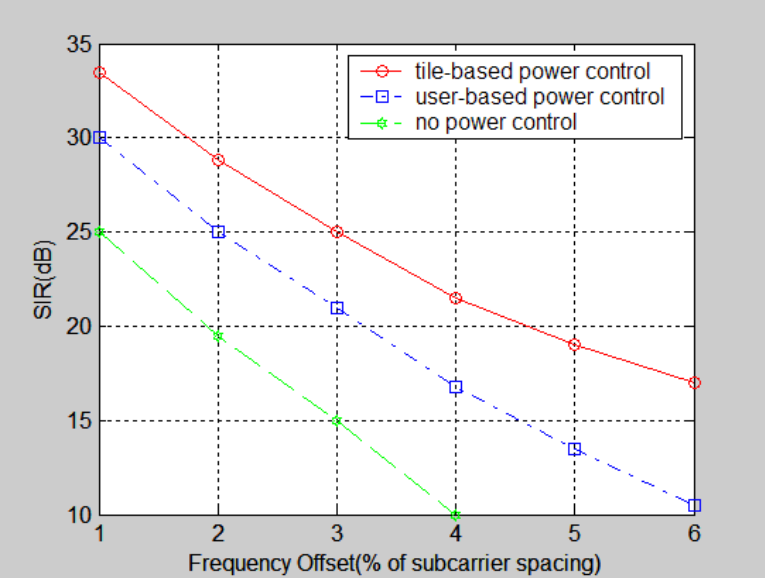

Fig.3 The SIR versus frequency offset

Three SSs transmit signals in the system with each one occupying one subchannel. It is assumed that each of the 6 tiles from one SS is located next to the tile of another SS as shown in Figure 1. Also as shown in Figure 1, the signals from two side SSs (green and blue) encounter frequency offsets of the same amount but different directions (toward center). The average signal-to-interference ratio (SIR) is measured over one subchannel (6 tiles) for the weakest SS. The results are shown in Figure 3. In case that no power control is applied, the simulation results are represented by green curve. If the user-based power control as specified in the current standard is used, the results are represented by blue curve. When both user-based power control and tile-based power control as proposed by this contribution are applied, the results are represented by the red curve.
By overcoming the frequency-domain fluctuation resulted from multipath fading, the tile-based power control provides about 4 dB gain when frequency offset is 1% of the subcarrier spacing. The gain increases when the frequency offset is larger.

4. Proposed Text

8.4.5.4.3 Enhanced Power Control
When the UL enhance power control is used, an Enhanced Power Control IE is sent using the exteneded UIUC=15 with subcode 0x01. An UL enhanced power control IE is used to keep the power balance between tiles within one SS when some tiles reside in the deep fading. The power control value is expressed in 2 bits and defined according to Table xxx. The power correction of tiles should be in the ascending order as the tile number.

The IE is unicasted to each SS. When used, the CID in the UL_MAP_IE() should be set to Basic CID of the SS .

Table xxx. Enhanced power control IE

Syntax	Size	Notes
Enhanced_Power_Control_IE(){		
Extended UIUC	4 bits	Ehanced Fast Power Control = 0x01
Number of Tiles	8 bits	Number of tiles for the targeted MSS
for (i=1; i<=n; i++) {		n=Number of tiles
Power correction	2 bits	Power correction indication, 00: no change; 01: +2dB; 10: -1dB; 11: -2dB
}		
}		